Research Bulletin No. 7 March, 1967

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Results of the Fourth Inter-American Spring Wheat Yield Nursery, 1963-1964[1)]

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Prior to 1960, a number of scientists who had had occasion to study uniform sets of material such as the International Rust Nursery of the United States Department of Agriculture, noticed that, apart from disease reaction, some varieties appear to be much wider adapted than others. Beginning in 1960, a series of Inter-American Spring Wheat Yield Nurseries have been seeded throughout the wheat growing regions of the hemisphere as well as at a few locations in the Near East and Africa. The results of three of these nurseries have been previously published (1,2,3), and the present publication includes the results of the fourth and final of these nurseries and a somewhat more thorough statistical treatment than was previously possible. These nurseries have been designed to furnish definitive, quantitative data concerning the range of adaptation of the major wheat types of the world under the range of environmental conditions of the American wheat growing areas.

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1) Jointly sponsored by: The International Wheat Improvement Program of the Rockefeller Foundation and the Wheat Improvement Program of the Instituto Nacional de Investigaciones Agrícolas (INIA), Secretaría de Agricultura y Ganadería, Mexico. The efforts of these two organizations are now coordinated through the International Maize and Wheat Improvement Center (CIMMYT).

2) Respectively: Geneticist, Rockefeller Foundation; Head, Cereals Investigations, INIA; Head, Wheat Improvement of the International Maize and Wheat Center; Plant Pathologist, INIA; Agronomists, INIA, and Head of Biometry Department, INIA.

A special acknowledgement is given to the 1963 group of Near East trainees that helped in the preparation of seed for the nursery. These included: Mohammed Khoja, Kiamil Behzat Raif, Alemayehu Wodageneh, Behrooz Sadri, Saleem Muhy El Sahrawardi, Mohamed Ramadan Draik, Ilyias Tunio, Sadettin Demiroz, Mohamed Wagdey, Ali Shukry and Amando Yambao. Also acknowledgement is made to Reyes Vega and Miguel Martinez for their help in preparing the trials, to Ing. José Luis Maya for help in preparing the tables and to Miss Judith Franco for typing the manuscript.

During the past few years, a parallel series of nurseries has been sponsored in cooperation with The Near and Middle East Wheat and Barley Improvement Project of the Food and Agriculture Organization of the United Nations to yield test a group of varieties from various countries under the environments of a number of Near and Middle East countries as well as those of the Americas. These trials have served as a complement to a program in which promising young scientists from these countries have been brought to Mexico for intensive practical training. The results of these trials have already been published (4, 5, 7).

The results from both series of nurseries have been remarkably similar and have furnished much valuable information concerning adaptation in spring wheats.

MATERIALS AND PROCEDURES

General

The trial consisted of 25 varieties representing the principal types of spring wheat seeded in the Americas. Plots consisted of three five-meter rows with four replications arranged in a simple lattice, repeated design. Seed was packeted for each row using a seeding rate equivalent to 100 kg./ha. for the variety Sonora 64. Adjustments were made for each variety so that the number of seeds per row was approximately the same as for Sonora 64.

Seed for the nursery was produced in increase plots at the Centro de Investigaciones Agrícolas del Noroeste (CIANO) at Ciudad Obregón, Sonora, Mexico. The nursery was prepared as part of the training of a group of FAO trainees under the supervision of Dr. N.E. Borlaug. The seed was treated with an organic mercurial seed disinfectant prior to being packaged. Instructions concerning seeding, nursery management and note taking as well as data sheets were included in each seed box. All nurseries sent out of Mexico were shipped by air.

Data were obtained from 12 locations in 8 countries representing the major wheat regions in South, Central and North America. These trials were seeded under both dryland and irrigated conditions, both fertilized and unfertilized, from 36°S latitude in Chile through 0° in Ecuador to 49° N in Manitoba, and from an elevation of 40 meters at Ciudad Obregón, Sonora, Mexico to 3,058 meters above sea level at Quito, Ecuador. A list of the cooperating stations and scientists as well as supplementary information is given in the appendix.

Choice of varieties

Twenty-five spring wheat varieties (Triticum aestivum) were included in the nursery. These included the principal varietal types that are presently grown in the hemisphere as well as representatives of the Egyptian, Australian and Pakistani wheats. Most of the varieties had been included in previous nurseries, but some new ones were included in an attempt to keep the nursery as current and meaningful as possible. The varieties included were:

United States and Canadian varieties:

1. Selkirk--a Canadian-developed variety that is still the most extensively grown variety in the moist parts of the northern hard spring wheat areas.

2. Thatcher--a Minnesota variety that was widely grown for many years in the northern United States and Canada and that is still widely grown in the drier regions of this area. It has been used as a standard for spring wheat quality and for that reason has been widely used in the parentage of many of the newer United States and Canadian lines.

3. Justin--one of the newer, commercial spring wheat varieties of the United States. It was developed in North Dakota.

4. Crim--a new Minnesota variety that is now in commercial production. It was included in the nursery before the variety was named and was carried by its experimental designation of Minn. II-53-404.

5. North Dakota # 81--an experimental line from North Dakota that is apparently somewhat better adapted to short day lengths than most United States and Canadian varieties. It was never actually released because cf quality considerations.

Argentine varieties:

1. Gaboto--one of the most important varieties in the northern part of the Argentine wheat belt.

2. Buck Atlantico--one of the most important varieties in the southern part of the Argentine wheat belt.

3. Magnif 41 and Magnif 42--two semi-commercial varieties.

4. Tacuarí--a recently released variety. It was included in the nursery before being named under the designation of Massaux # 5 x Gaboto.

Mexican varieties:

1. Nainari 60--an important tall commercial variety in Mexico from 1960 through 1962 and still widely used in crosses. It has also shown good adaptation in several Near Eastern countries

as well as in previous Inter-American Nurseries.

2. Lerma Rojo--a tall variety that was the principal commercial variety in Mexico from 1955 to 1961.

3. Lerma Rojo 64 A--a dwarf version of the original Lerma Rojo, derived through backcrossing.

4. Pitic 62--the first semi-dwarf variety released in Mexico. It has yielded well in previous Inter-American nurseries and was the highest yielder in all three Near East-American nurseries but is currently grown on only a limited commercial average in Mexico because of its susceptibility to new races of stem rust.

5. Pénjamo 62--one of the first semi-dwarf varieties released in Mexico. It has occupied over half of the Mexican wheat average for the past several years.

6. Sonora 64--the shortest strawed variety that has been commercially released in Mexico to date. It is currently recommended only for areas where leaf rust is not a serious problem.

7. Mayo 64--one of the newer semi-dwarf varieties.

Colombian varieties:

1. Nariño 59--the most important commercial variety in Colombia from 1960 through 1962 when a new race of stripe rust ended its usefulness in southern Colombia. It is still widely used in the departments (i.e. states) of Cundinamarca and Boyacá and was the highest yielding variety in the first Inter-American Spring Wheat Yield Nursery.

2. Bonza 55--an important commercial variety. It has maintained an effective level of field resistance to stripe rust for over 10 years which is almost unique with the explosive race situation of Colombia.

3. Frocor-Kenya AD x Gabo--an extremely early, stripe rust resistant experimental line. It was never commercially released.

Australian varieties:

1. Gabo--a variety of very wide adaptation both in Australia and many other countries. It is susceptible to stripe rust.

2. Double Insignia--a short strawed variety; susceptible to stripe rust.

Egyptian varieties:

1. Giza 144--a widely adapted variety representative of the present commercial varieties used in Egypt.

Brazilian varieties:

1. Carazinho--an important commercial variety reported to be able to produce relatively good yield on acid soils. It has good

stripe rust resistance under most conditions.

Pakistani varieties:

1. C-271--an important commercial variety representative of the type of wheats cultivated in both Pakistan and India.

Data handling and summarization

As far as possible, data were converted to metric units or percentages for presentation in this report. Every effort was made to assure the correctness of such conversions as well as the accuracy of translations of terms from other languages and the interpretation of supplementary information. The authors take full responsibility for any errors that might have been made. Data are not presented in the table nor were analyses run for traits where no differential varietal effect was observed.

Yield data were requested from the central row of each three-row plot. All three rows were harvested by some cooperators in order to have sufficient grain for test weight and 1000 grain weight. Yields were converted from the units reported by the cooperator to kilograms per hectare. For readers more accustomed to yield in bushels per acre, 1000 kilograms per hectare of wheat is equivalent to approximately 15 bushels per acre.

Both test weight and 1000 grain weight data were requested as a measure of grain quality because some cooperators do not have test weight equipment. In some cases the cooperator had to combine seed from the four replications to have enough seed to take a test weight determination. Test weight is reported in kilograms per hectoliter, and 1000 grain weights are reported in grams. For readers more accustomed to test weight expressed in pounds per bushel, one kilogram per hectoliter = 0.8018 pounds per bushel, i.e. 75 kilograms per hectoliter is approximately 60 pounds per bushel.

For statistical analysis the rust notes were converted to a coefficient of infection similar to that used by Dr. W.Q. Leogering in the United States Department of Agriculture's International Rust Nurseries. This coefficient is calculated by multiplying the percentage of infection by a "response value" for each infection type. Thus, the coefficient combines both the amount of infection as well as the reaction type. The response values are as follows: 0 = 0; VR (very resistant) and R (resistant) = 0.2; MR (moderately resistant) = 0.4; M (intermediate) = 0.6; MS (moderately susceptible) = 0.8; and S (susceptible) and VS (very susceptible) = 1.0. The coefficients can be analyzed statistically as well as correlated with yield and other traits to estimate the degree of association between rust attack and other traits. To avoid handling of fractional values, coefficients less than 1.0 and more than 0 were rounded to 1.0, and all other values were rounded to the nearest whole number.

In the case of cooperators who reported only percentage of rust, this was used directly as the coefficient, and for the occasional case where only the infection type was reported, the response value was used as the coefficient. Due to the fact that 0 values were common and that the coefficients do not usually fit a normal distribution, the coefficients were transformed as $\sqrt{\text{coefficient} + 1}$, i.e. $\sqrt{X + 1}$, for analysis. While other transformations may have been more appropriate in specific cases, the $\sqrt{X + 1}$ transformation considerably improved the normality of the distributions. The $\sqrt{X + 1}$ values were the ones used for all statistical analysis and are the ones presented in the tables of results for locations in which data for the trait were reported in more than one replication. Where the rust note was taken in only a single replication, the actual notes are presented in tables, but the coefficients transformed to $\sqrt{X + 1}$ were used for correlations.

Throughout this report, the terms <u>stripe rust</u>, <u>stem rust</u> and <u>leaf rust</u> are used instead of <u>yellow rust</u>, <u>black rust</u> and <u>brown rust</u> such as are used in the Near East and instead of the scientific names of the causal organisms. Stripe rust readings are normally taken on the leaves, but under severe conditions an additional note can be taken on the attack in the head or spike. This is usually taken as the average percentage of infected spikelets in the plot. Two locations reported this type of data in addition to the usual leaf note, and these data were also transformed to $\sqrt{\% + 1}$.

Lodging was recorded as percentage of lodged plants, and shattering was recorded as average percentage of shattered spikelets or percentage of yield lost due to shattering. Both lodging and shattering data were transformed into $\sqrt{\% + 1}$ to normalize their distribution. Lodging data from Minnesota were reported as a score, and these were not converted to percentages nor used in averages with data from other locations. The cooperators were urged to include data for any other factor for which differential data could be recorded, and such additional factors were often the most important ones in influencing yield at that site. These were analyzed and presented wherever available.

<u>Statistical treatment</u>

At any given location, an analysis of variance was performed for all traits on which data were reported from more than one replication. Pertinent information from these analyses of variance are presented for each trait as well as the mean for each variety for each trait in Table 1, 3, 5, 7, 9, 11, 13, 15, 17, 19, 21, 23 and 24. The information from these analyses includes the statistical level of significance, coefficient of variation, efficiency of the lattice design as compared to a randomized block design, the average comparison standard error, the least significant difference at the 5% level and the mean for the trait.

The statistical level of significance includes from 0.5% to 25% (9) rather than just the usual 5% and 1% levels. "NS" indicates non-significance at even the 25% level. Efficiency of the lattice as compared to a randomized block design was computed by the usual methods (6). If the efficiency was less than 100%, a randomized block analysis was used, and the letters "RB' are inserted in the tables instead of the efficiency of lattice. The comparison standard error presented in the tables for experiments analyzed as lattices is the average of the between and within block comparisons as calculated by the usual formula (6). If the experiment was analyzed as a randomized block, the comparison standard error was calculated as:

$$\sqrt{\frac{2\ (\text{Error Mean Square})}{\text{number of replications}}}$$

The least significant difference (LSD) for the 5% level is also presented (9). The disadvantages of this test as compared, for example, to the Duncan or other tests as well as the mis-uses that are frequently made of the LSD are fully appreciated. Nevertheless, LSD values are presented because: it remains the best understood statistical test in many countries, it still serves as a reasonably reliable basis of comparison, and it lends itself to more concise presentation in the tables than the various sequential range tests. Readers wishing to use the Duncan multiple range test, for example, may compute the appropriate standard error from the comparison standard error presented in the tables.

Considerable understanding as to which factors are influencing yield and the interactions between these factors may be gained by studying the correlations presented in Tables 2, 4, 6, 8, 10, 12, 14, 16, 18, 20, 22 and 25. The correlations are between the means of all traits for which data were reported. Correlations were calculated between the means rather than using the raw data first because this appeared to be somewhat more meaningful genetically and second because some types of data were frequently reported for only one replication.

The means of each character for each variety were also used to compute a multiple regression for yield considering all other variables for which differential data were reported as "independent" variables.

It is realized that many of these variables are not truly independent from either a statistical or a biological viewpoint. The multiple regression analyses for each location are presented in the same tables as the correlation values, and both partial regression coefficients and "t" values are presented for each variable. In computing multiple regressions it is often customary to begin with the variable explaining the largest amount of variance of the dependent variable (in this case, yield) and continue adding variables that account for the next most amount of variance until the "t" values for additional variables are no longer significant. When this point is reached, no more additional variables are included. It will be noted, however, that coefficients and "t" values are included for all "independent" variables. This was done partially because the magnitude of the "t" value (sign ignored) may be a measure of the relative importance of a variable in determining yield. Such interpretations should be made with some care, however, particularly when there are two variables that are not truly independent or that may measure much the same thing (e.g. heading date and maturity date).

For readers who have not had much experience with multiple regression, the R^2 value is the amount of the variance for yield that can be accounted for by the regression equation. This regression equation consists of a constant term plus coefficients to be multiplied by the values for each of the independent variables. The equation can be used to calculate an expected yield for each variety based on the values for each of the independent traits that were measured. That is, we may compute an expected yield for a variety on the basis of its maturity, rust reaction, straw strength, etc. For example, the expected yield of variety 1 at Encarnación, Paraguay can be calculated as (see data in Table 5 and coefficients and constant term in Table 6):

$$Y = 405.652 + 17.4637(27.2) - 53.7845(80) + 33.4123(132) + 10.4989(94) = 1975.225 \text{ or } 1975$$

For the reader's convenience, expected (i.e. calculated) yields using the multiple regression equations are presented in Table 28 for all locations reporting more than one independent variable. The differences between observed and calculated yields are presented in Table 29. In attempting to verify any of the figures in these two tables, it should be remembered the data and coefficients have been rounded off for efficient presentation in the tables while the values in Tables 28 and 29 were calculated with un-rounded figures. Incidentally, as Ostle (8, p223) suggests, R (i.e. $\sqrt{R^2}$) may be thought of as a linear correlation between the expected and observed yields. While many workers will find the multiple regression analyses interesting and useful, a full understanding is not essential to the interpretation of the yield data or the factors influencing yield.

The overall summary of the data reported for all varieties is presented in Table 26. These are the means for all traits averaged over all locations from which differential data were reported. As will be noted, the number of locations differs between traits. No combined analysis of variance over all locations was attempted due to some disparity in data recording, heterogeneity of variances and to the fact that the data were incomplete at some locations particularly for varieties that are sensitive to short day lengths. Data were used for only the normal planting date at Ciudad Obregon in computing these averages so as not to bias them unduly toward the results from this location.

The correlation values in Table 27 were calculated from the means of the traits averaged over all locations where both traits were measured. These are perhaps the best estimates of the relationship between traits.

Because of the unique nature of the data reported being representative of a diverse group of varieties tested over a sizable part of the hemisphere's spring wheat area, the philosophy of the authros has been to try to provide the reader with a maximum amount of usable information. No attempt has been made to "digest" the data and explore all of its ramifications, but it is hoped that students and scientists alike will continue to find applications and interpretations that cannot be visualized today.

RESULTS AND DISCUSSION

Pitic 62 and Penjamo 62 occupied first and second place, respectively, in overall performance with average yields of 2963 and 2841 kilograms per hectare (Table 26). One or the other of these two varieties has now had the highest yield in all three of the Inter-American Spring Wheat Yield Nurseries in which they were entered (2, 3). Additionally, Pitic 62 was the highest yielding variety in all three of the Near East-American Spring Wheat Yield Nurseries (4, 5, 7). In the present nursery, Pitic 62 yielded 581 kg./ha. more than the average of all 25 varieties included in the experiment and 1526 kg./ha. more than the lowest yielding variety, Thatcher.

As this is the fourth and final Inter-American Spring Wheat Yield Nursery, it seems appropriate to compare the highest yielding five varieties in all four nurseries (1, 2, 3 and Table 26):

INTER - AMERICAN SPRING WHEAT YIELD NURSERIES

4th (1963-64) (12 locations)	3rd (1962-63) (11 locations)	2nd (1961-62) (4 locations)	1st (1960-61) (18 locations)
Pitic 62	Penjamo 62	Pitic 62	Nariño 59
Penjamo 62	Nainari 60	Preludio	Bonza 55
Tacuarí	Pitic 62	Nainari 60	Nainari 60
Nainari 60	Nariño 59	Carazinho	Orofen
Gaboto	Lerma Rojo 64 A	Lerma Rojo	Lerma Rojo

Considering only varieties that were entered two or more years, the highest yielding were (means weighted for number of locations):

Variety	Yield kg./ha.	# of years entered
Pitic 62	2806	3
Penjamo 62	2790	2
Nainari 60	2697	4
Nariño 59	2613	4
Bonza 55	2562	4

In general, it can be seen that the varieties that have yielded well in previous years are the higher yielding ones in this nursery also. It will be noted in studying the data from each location that the varieties with the highest overall yields were not as consistent in their yields at individual locations as had been true in the three previous nurseries. The climatic conditions were apparently somewhat unusual at least as compared to these three years. Some of the location means appear somewhat lower than usual particularly at the non-irrigated sites. Nevertheless, there was still a marked tendency for varieties to behave similarly over a wide range of conditions as has been observed in all previous trials, both Inter-American and Near East-American. This is particularly significant when we consider the tremendous diversity of latitude, elevation, day length regime, fertilizer practice, water availability and disease complexes and considering that it is for a crop that has traditionally been considered rather specific in its adaptation

One may wonder why the belief that varieties cannot be produced with broad adaptation has become so deeply ingrained in the attitudes of many wheat breeders. Undoubtedly the biggest factor has been that few wheat breeders have had occasion to see a wide range of material planted under a number of quite different environments. In fact, the authors have observed that many workers do not have a clear idea as to the research program even in neighboring countries or states with similar conditions. In many cases this is due to political difficulties rather than a lack of scientific curiosity on the part of the individual worker. Thus, the scientist has not had the opportunity to study materials under different environments and just intuitively assumes that each environmental niche must ideally have its own set of varieties.

Another reason that some scientists have thought that breeding for broad adaptability is not practical or perhaps not even desirable may be due to the fact that variety by location interactions are frequently encountered in varietal trials of wheat as well as other crops. Such interactions imply that all varieties do not respond identically to all environments, but some workers have apparently concluded that these interactions mean that a different set of varieties are required for all environments. This is not necessarily so. The seeming paradox can be understood by a simple illustration: if five tall, weak-strawed varieties and five strong-strawed varieties are planted in an experiment without fertilizer and also at another site with heavy fertilization, both groups of varieties will usually yield similarly without fertilizer but the strong-strawed group will yield infinitely better with fertilizer than the weak-strawed group (assuming fairly adequate moisture). A statistical analysis will reveal a strong and highly significant variety by location interaction, but it does not follow that the varieties that yield the best with fertilizer will not also yield the best without fertilizer. In fact, it is generally found that they will.

This point was discussed in a previous publication (7, p 8-11) in which the varieties were compared between the four highest yielding and the four lowest yielding sites in the third Near East-American Spring Wheat Yield Nursery. The varieties that performed the best under better management tended to do at least as well as other varieties under poorer conditions. This has important implications for the type of management to be applied to breeding plots as well as in understanding variety by location interactions.

There is still undoubtedly a lot of variety by location interaction that cannot be so explained, but another fallacy is assuming that this interaction applies equally to all varieties. As is made abundantly clear by the now published international yield trials, there are varieties that behave consistently under many environments--some do consistently well and some consistently poor.

Let us consider an example of each. Pitic 62 had the highest average yield in two of the three Inter-American Spring Wheat Yield Nurseries in which it was entered and in all three of the Near East-

American trials (1, 2, 3, 4, 5, 7). Perhaps more significant is the fact that Pitic 62 was among the five highest yielding varieties in 15 out of 28 locations in the three Inter-American trials in which it was entered and among the five highest yielding varieties in 35 out of the 51 locations in the Near East-American tests. When we consider the fact that its poor showing (e.g. Quito, Ecuador, Table 9) in some locations can be accounted for by inadequate disease resistance, the genetic potential for adaptation of the variety is indeed impressive.

Thatcher is also consistent in yield: it is almost always one of the lowest yielders. It had the lowest average yield in all three of the Inter-American Spring Wheat Yield Nurseries in which it was included. It was not included in the first Inter-American because it was so poorly adapted that it didn't produce enough seed in the seed plots in Ciudad Obregon to be included. Thatcher was among the five lowest yielding varieties in 21 out of the 28 locations in which it was tested. Its poor adaptation in many locations can be partially explained by the fact that it is extremely sensitive to short day lengths which makes it far too late to compete with day length insensitive types. Nevertheless, Thatcher has only once placed higher than 17th at any location including those from Minnesota, North Dakota and Manitoba where the variety has been widely used both commercially and as a parent.

Day length sensitivity is a major factor that has limited the adaptation and usefulness of many United States-Canadian spring wheat varieties. In the case of spring wheats, it appears that instead of there being long-day and short-day varieties, there are long-day wheats and insensitive wheats. The long-day wheats are adapted only to long summer days such as occur in Minnesota or Manitoba. On the other hand, the insensitive wheats are adapted to both short and long day conditions. As the long day segregates are quite late under a short day length regime, they are automatically discarded by the breeder, and all wheats coming out of a program located where the day length is short will be insensitive.

To illustrate the phenomenon with the present data, Thatcher was 20 days later in heading than Penjamo 62 under the less than 12 hour day length of the winter season in El Roque (Table 13) and 28 days later under the almost exactly 12 hour day length of Quito (Table 9). However, Thatcher headed within one day of Penjamo 62 in Minnesota (Table 21). Many other illustrations of the phenomenon can be found from both the present and previously published yield trial results.

Ironically, the day length sensitivity does not appear to confer a marked yield advantage even under long day conditions--at least as suggested by international yield trial data. Apparently, a group of wheats was encountered with good bread making qualities and these by chance happened to be adapted to only long day lengths. As these wheats have figured prominently in the parentage of most new spring wheat varieties for the northern Great Plains, the day length sensitivity trait has been carried along inadvertently.

Thus, despite the fact that a great deal of very high level research was required for the development of these varieties, they have had little impact either commercially or as parents outside of the environment where they were selected largely because of their sensitivity to short day lengths.

For the above discussion, day length sensitivity in spring wheats has been somewhat over-simplified. There appear to be modifying genes, temperature effects, intermediate reactions and several other things that were not mentioned, but the long day requiring vs. insensitive situation explains most of the phenomenon. A good deal of basic research is needed for a better understanding of all the mechanisms involved.

While the importance of day length sensitivity in sharply limiting adaptation has not been appreciated by most wheat breeders, its existence is not a new discovery. Over 30 years ago, Vavilov (10) recognized that wheats from the Near East, where they are cultivated under a less than 12 hour day length, are well adapted at all day lengths, but that wheats from Europe and Russia are limited to the long day conditions of those areas. As Vavilov described it (10):

> "Varieties of wheat sharply differ in their relations to <u>length of daylight.</u> With many northern forms of wheat of western Europe and SSSR, the short day of the south lengthens the period up till heading. The northern long day accelerates this phase. Many central Asiatic and Iranian varieties are relatively insensitive to changes in length of day."

The Colombian varieties and several Mexican varieties showed the best adaptation in the first Inter-American nursery. These varieties have since been eclipsed by high yielding dwarfs. Nevertheless, the Colombian lines have continued to show remarkably wide adaptation, particularly considering how different the climatic conditions of the Colombian wheat areas are from the conditions where most of the international nurseries are seeded. Colombia would seem to be an example of a site that is quite valuable as a testing location regardless of the size of the wheat area of the country. Such locations are often the key to making efficient, adapted selections. It is felt that such locations must be kept closely tied into an international program so that this adaptation may continue to be incorporated into strong-strawed, high-yielding backgrounds.

The Argentine wheats performed better in the present nursery than in the previous ones. They appear to have a somewhat different type of adaptation that would be desirable to combine with that present in the Mexican-Colombian wheats. Gaboto has yielded reasonably well in all four Inter-American Nurseries and apparently does well in crosses (e.g. Tacuarí).

The results from both the Near East-American and Inter-American nurseries have been quite similar. After observing this for a number of years, it was decided to combine them into a single, world-wide International Spring Wheat Yield Nursery rather than have one nursery for the Near East and another for the Americas. Such a nursery will undoubtedly give even more meaningful answers to the possibilities of breeding for adaptation in wheat.

To make this nursery as useful as possible, suggestions are welcomed concerning improvements in the design and management of the nurseries, number of varieties, plot type, presentation of results, analysis, etcetera. So that the nursery can be kept as current as possible and thereby of more immediate usefulness, breeders are urged to submit their best new commercial varieties and/or most promising experimental lines for including in the nursery. Seed of such material should arrive in Mexico by September 15 for planting in the seed plots in Ciudad Obregón, Sonora. It is requested that 400-500 grams of seed be sent although less can be used if necessary. Obviously, the total number of entries that can be included in such a test is limited, but it is hoped that the best representatives of each of the major spring wheat regions of the world can be included.

SUMMARY

Twenty five spring wheat varieties representing the major types grown in the Americas as well as certain other areas were entered in a replicated international yield trial. Results were obtained from 12 locations in 8 countries from Chile to Canada under both dryland and irrigated conditions and from 40 meters above sea level to over 3000 meters above sea level.

In addition to yield, wherever possible data were obtained on disease reaction, height, flowering and maturity date, lodging, shattering, 1000 grain weight and test weight. The data from all traits were analyzed statistically when data were reported on more than one replication, and correlations were calculated between the means of all traits measured at each location. A multiple regression analysis of yield on the other variables was also calculated wherever more than one independent variable was reported.

The highest yielding varieties over the 12 locations were Pitic 62, Penjamo 62, Tacuarí, Nainari 60 and Gaboto. Tacuarí and Gaboto are Argentine varieties, and the other three are Mexican. As have previous international yield nurseries, both in the Americas and through the Near East, the results show that is possible to breed varieties that have a much wider range of adaptation than is usually believed possible. There was a marked tendency for varieties to maintain their relative rankings at all locations whether they were fertilized or not fertilized, irrigated or rainfed and over a wide range of elevations.

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APPENDIX

Cooperating stations and scientists with suplementary data as supplied by the cooperators.

ARGENTINA

Paraná, Entre Ríos
Cooperators: Ing. Alberto Chabrillon and wheat research staff of station
Latitude: 31° 50' S
Longitude: 60° 31' W
Elevation: 110 meters above sea level
Date of planting: July 13, 1963
(Effective germination: July 22, 1963)
Precipitation: 863.1 mm for 1963 (annual average 970 mm)
Distribution during growing season: July 39.2 mm, August 30.4 mm, November 176.2 mm, December 108.2mm
No irrigation used.
Fertilizer used: none
General description of weather conditions during time of test: There were no damages due to frost, hail or extreme high or low temperatures. The drought during the winter and part of the spring was the principal cause of the low yields.
Disease development: The stem and leaf rust attacks were very heavy, *Septoria tritici* also occurred, but it was difficult to take the note accurately, and the notes taken were undoubtedly lower than the attack. *Septoria* notes were, therefore, not included in the analyses. There were late attacks of *S. nodorum* and *Fusarium*, but notes were not reported.
Weed, insect and pest problems: There were no weeds at all until flowering and then were not damaging. There was no insect, bird or rodent damage.
Date when different notes were taken:

1. Drought: October 1 (Scale of 0 to 4 with 4 being seriously affected)
2. *Septoria tritici*: October 16 (little differential effect noted and therefore not analyzed)
3. Stripe rust: October 16 (no differential effect noted and therefore not analyzed)
4. Stem rust: November 14
5. Height, lodging and shattering (no differential effect) were observed at harvest. The later varieties were harvested December 12, 1963.

Pergamino, Prov. de Buenos Aires
Cooperators: José Rath and Héctor Conta
Latitude: 33° 52' 58" S
Longitude: 60° 35' 15" W

Elevation: 68 meters above sea level
Date of planting: July 23, 1963
(Effective germination: August 3, 1963)
Precipitation: (1963) January 69.7 mm, February 84.8, March 156.1, April 45.1, May 26.9, June 52.9, July 23.6, August 49.1, September 40.9, October 77.8, November 60.1, December 211.7.
Fertilizer used: none
General description of weather conditions during time of test: The year was characterized by excessive moisture and the absence of the necessary warm temperatures during heading and maturity. During the first of December there were heavy rains and strong winds that caused the experiment to lodge completely.

PARAGUAY

Estación Agrícola Experimental, Encarnación
Cooperator: Ing. Sinforiano Paniagua S.
Latitude: 27° 20' S
Longitude: 55° 50' W
Elevation: 2000 meters above sea level
Date of planting: May 21, 1964
(Effective germination: May 30, 1964)
Precipitation during cycle of the test: 534 mm
Fertilizer used: 250 kg./ha. of "Engro 15-15-15"
(i.e. 37.5 kg./ha. each N, P_2O_5 and K_2O)
General description of weather conditions during time of test:
A heavy storm occurred in August with some hail.
Relative humidity: May 76%, June 75%, July 70%, August 73%, September 71%, October 61% and November 60%
Weed, insect and pest problems: weeds controlled by hand.

CHILE

Santiago, Estación Experimental Central "La Platina", Provincia de Santiago
Cooperators: Ignacio Ramirez A., R. Gonzalez B., P. Parodi P., and O. Moreno M.
Latitude: 36° 40' S
Longitude: not reported (approx. 72° W)
Elevation: 625 meters above sea level
Date of planting: August 2, 1963
(Effective germination: August 17, 1963)

Precipitation: 465 mm until November 1963, after which the trial was irrigated 3 times, the last irrigation was on December 10, 1963.

Fertilizer used: 128 kg./ha. of N and 120 kg./ha. of P_2O_5 applied as sodium nitrate (salitre sódico) and triple superphosphate.

General description of weather conditions during time of test: Good rainfall during the winter. Cool, moist spring with rains until the last half of November. These conditions assured good moisture that phase of plant development.

Disease development: Stripe rust was very severe in 1963. Leaf rust began early and developed aggressively on susceptible material causing considerable damage. The nursery was artificially inoculated with stem rust using a mixture of races prevalent in the central region of Chile. This included three biotypes of race 15 B, three of race 29, one of race 17 and a group of unidentified collections made throughout the central wheat zone. The inoculation was successful and produced a heavy attack of stem rust.

Weed, insect and pest problems: Weeds were controlled with 2, 4 - D. No other pests were of importance.

Dates when different notes were taken.

1. Stripe rust: October 23 (head note taken December 9)
2. Leaf rust: November 21, 1963
3. Stem rust: January 6, 1964

ECUADOR

Quito, Santa Catalina Experiment Station, Pichincha, Quito
Cooperators: Cereal program, INIAP
Latitude: 0° 22' S
Longitude: 78° 33' W
Elevation: 3058 meters above sea level
Date of planting: December 18, 1963

Precipitation:		
	December 18-31	118.1 mm
	January (1964)	60.9
	February	59.2
	March	44.9
	April	315.2
	May	83.1
	June	85.4
	TOTAL	766.8

Fertilizer used: 300 kg./ha. of a 10-30-10 formula to give an equivalent of 30-90-30 of N-P_2O_5 - K_2O

General description of weather conditions during time of test: It was an abnormally wet year during harvest.

Disease development: It was not considered a normal year for a disease standpoint because of the unusual climatic conditions. The amount of stem rust was particularly low.

Weed, insect and disease problems: The test was hand weeded twice. No other problem was encountered.

Date when different notes were taken: Disease notes were taken February 28, March 9 and May 18, 1964.

Flowering and maturity observations were made daily.

GUATEMALA

"Labor Ovalle" Experiment Station, Quezaltenango

Cooperators: Jorge Luis Juárez P.

Latitude: 14° 52' N

Longitude: 91° 33' 14" W

Elevation: 2380 meters above sea level

Date of planting: July 13, 1963

(Effective germination July 20, 1963)

Precipitation during the cycle of the test: 408 mm

Fertilizer used: 85 kg./ha. of N and 106 kg./ha. of P_2O_5 applied in a 16-20-0 formula

General description of weather conditions during time of test: There was a prolonged dry period during the vegetative period from July 23 until September 17. The average daily high temperature was approximately 22°C, and the average daily low was 3° C.

Disease development: The most important disease in the area is stripe rust followed by *Septoria tritici*, leaf rust and stem rust. They generally occur during September and October.

Weed, insect and pest problems: Weeds were controlled by a 2,4-D application 35 days after seeding. No other pests were encountered.

Dates when different notes were taken: Two notes were taken for all disease with the first being taken in October and the second in November. (The mean of the two notes for leaf rust is presented in Table 11, and the first note was used for stripe rust and Septoria). Agronomic notes were taken as recommended in the instruction sheet accompanying the nursery.

MEXICO

Centro de Investigaciones Agrícolas del Bajio (CIAB)

El Roque, Guanajuato
Cooperators: Ing. Ricardo Urbina, Ing. Rodolfo Moreno G., Ing. Genaro Cruz, Dr. Jacobo Ortega
Latitude: 20° 34' N
Longitude: 100° 28' W
Elevation: 1650 meters above sea level
Date of planting: December 18, 1963
Fertilizer used: 120 kg./ha. of N and 40 kg./ha. of P_2O_5
Weed, insect and pest problems: none

Centro de Investigaciones Agrícolas del Noroeste (CIANO)
Ciudad Obregon, Sonora
Cooperators: Ing. Alfredo Garcia, Ing. Ricardo Rodriguez, Ing. Arnoldo Amaya
Latitude: 27° 20' N
Longitude: 109° 54' W
Elevation: 40 meters above sea level
Date of planting: Two nurseries were planted at this location. One was planted on October 13 earlier than is normal for commercial wheat production for the area. The other was planted on October 29 which is early to normal for the zone. Only the normal (i.e. October 29) data were used in computing the overall averages in Table 26.
Fertilizer used: 120 kg./ha. of N
Weed, insect or pest problems: none
Note: Data were taken for physiological leaf firing for both nurseries. The data were taken on a 0 to 4 scale with 4 being the most severe.

UNITED STATES

Agronomy Dept., College of Agriculture, University of California, Davis, California
Cooperator: J. Caswell Williams
Latitude: not given (approx. 38° 30' N)
Longitude: not given (approx. 121° 40' W)
Date of planting: December 27, 1963
" , wheat is not irrigated at Davis. After mid-January, 1964, we had no rainfall; so, the season and December were wetter than usual so that we planted later than we would ordinarily."
Disease development: none

Institute of Agriculture, Dept. of Agronomy and Plant Genetics, University of Minnesota, St. Paul, Minnesota.
Cooperators: D.R. Johnston, E.C. Gilmore and E.R. Ausemus
Latitude: 45° 00' N
Longitude: 93° 10' W
Elevation: 273 meters above sea level
Germination: May 4, 1964
Precipiation during the cycle of the test: May through July, 191 mm
Fertilizer used: none
General description of weather conditions during time of test: "Generally drier and warmer than normal. Good spring moisture produced excellent stands, but hot mid season, coupled with drought conditions, hastened maturity and reduced yields."
Disease development: "Slow and not much of a factor in yield - because of drought"
Weed, insect and pest problems: Weeds were controlled by hand. Some wheat stem maggot occurred, but there were no varietal differences.
Date when different notes were taken:

1. Heading- every 2-3 days
2. Height- July 20
3. Lodging- July 20
4. Stem rust- July 14
5. Leaf rust- July 14
6. Shattering- August 7 (none observed)

Agronomy Dept., North Dakota State University, Fargo, North Dakota
Cooperators: Wheat research team
Latitude: 46° 54' N
Longitude: 96° 48' W
Irrigation: none

CANADA

Research Branch, Canada Dept. of Agriculture, Box 6200, Winnipeg 1, Manitoba
Cooperator: A.B. Campbell
Latitude: 49° 40' N
Longitude: 97° 10' W
Elevation: 227 meters above sea level
Date of planting: May 26, 1964
Precipitation and irrigation: approx. 169 mm
Fertilizer used: none

General description of weather conditions during time of test:
Cold and wet in June, hot and dry in July and cool and wet in August.

Disease development: good epidemics of leaf and stem rust

Weed, insect and pest problems: none

Date when different notes were taken:

1. Lodging - at ripening
2. Shattering - 2 weeks after ripening

TABLES

TABLE 1. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Paraná, ARGENTINA, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to: flowering	Days to: maturity	Height cms.	Lodging $\sqrt{\% + 1}$	Stem rust	Leaf rust	Drought reaction
Gaboto	Argentina	1	1738	75.9	26.6	78	123	79	4.49	60 S	0	1.0
Crim	U.S.A.	3	1558	77.7	32.4	90	137	87	6.47	0	2 MS	.6
North Dakota # 81	U.S.A.	6	1519	74.1	31.0	76	120	73	3.82	5 R	0	1.4
Magnif 41	Argentina	16	1514	70.3	31.0	76	124	83	5.25	10 S	10 S	1.0
Gabo	Australia	13	1492	61.2	26.7	78	124	74	5.65	80 S	T R	.4
Tacuari	Argentina	2	1410	75.9	25.7	75	122	79	5.32	30 S	50 S	1.4
Nainari 60	Mexico	14	1261	66.2	32.7	76	121	66	4.49	70 S	10 S	1.3
Nariño 59	Colombia	12	1144	67.6	26.0	71	120	79	5.30	5 MR	20 S	1.1
Penjamo 62	Mexico	24	1127	69.1	29.2	69	117	66	8.32	1 S	2 S	.5
Mayo 64	Mexico	18	1018	63.1	25.0	78	122	62	3.70	2 S	20 S	1.5
Giza 144	Egypt	7	992	71.4	30.9	79	122	68	4.10	20 S	30 S	1.6
Sonora 64	Mexico	20	985	78.6	31.5	58	114	63	3.26	0	5 S	1.0
Magnif 42	Argentina	4	944	77.0	27.1	75	122	72	5.07	5 S	80 S	1.9
Carazinho	Brazil	22	943	72.7	27.9	77	124	83	5.10	80 S	20 S	1.8
Lerma Rojo 64 A	Mexico	19	854	71.4	25.7	69	116	73	7.72	0	60 S	.6
Selkirk	Canada	11	788	67.1	24.1	99	141	79	6.09	2 MS	20 MS	1.0
Bonza 55	Colombia	15	776	62.8	19.1	77	124	75	5.01	0	40 S	.9
Pitic 62	Mexico	10	740	65.5	22.7	75	117	63	3.63	1 S	90 S	.9
Fr-KAD x Gb	Colombia	23	707	75.0	28.4	56	112	72	7.18	0	90 S	1.2
Lerma Rojo	Mexico	9	693	68.2	29.2	72	116	82	6.90	T R	90 S	1.5
Justin	U.S.A.	8	607	64.2	18.7	101	141	80	6.31	0	15 S	1.5
Buck Atlantico	Argentina	17	453	69.1	20.0	81	132	76	8.30	80 S	90 S	1.2
Thatcher	U.S.A.	5	409	64.4	14.4	105	143	81	6.22	30 S	80 S	1.4
C-271	Pakistan	25	358	60.0	21.4	72	119	70	5.56	40 S	90 S	2.1
Double Insignia	Australia	21	303	63.3	21.5	86	135	61	6.54	25 R	70 S	1.7
Statistical level of significance			0.5%	(only	(only	(only	(only	0.5%	0.5%	(only	(only	1.0%
Coefficient of variation			26.1%	1 rep.)	1 rep.)	1 rep.)	1 rep.)	8.3%	23.5%	1 rep.)	1 rep.)	48.0%
Efficiency of lattice			125%					147%	103%			104%
Mean			973	69.3	26.0	78	124	74	5.59	3.58 1/	5.55 1/	1.2
Comparison std. error (ave.)			196					4.8	.97			.4
Least significant difference, 5%			393					9.6	1.94			.8

1/ Mean of coefficients transformed to $\sqrt{X+1}$

TABLE 2. Correlations between the means of 10 variables and the multiple regression of yield on the means of 9 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Paraná, ARGENTINA, 1963-64.

	Correlations (r); d. f. = 23									Multiple Regression R^2 = .862 9 "independent" variables constant term = 1423.895	
	Yield	Test wt.	1000 grain wt.	Days to flowering	Days to maturity	Height	Lodging $\sqrt{\%+1}$	Stem rust $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 15
Test wt.	.47*									15.9880	1.543
1000 grain wt.	.67**	.59**								17.1528	1.156
Days to flowering	-.19	-.35	-.53**							16.8106	1.297
Days to maturity	-.23	-.26	-.52**	.95**						-26.8057	-1.603
Height	.25	.23	-.05	.38	.40*					11.6471	1.721
Lodging $\sqrt{\%+1}$	-.35	-.09	-.25	.12	.23	.30				-59.9755	-1.563
Stem rust $\sqrt{X+1}$	.14	-.12	-.06	.10	.09	.15	-.03			21.9442	1.600
Leaf rust $\sqrt{X+1}$	-.77**	-.21	-.51**	-.05	.05	-.12	.30	-.06		52.7753	-2.443*
Drought reaction	-.44*	-.06	-.20	.09	.05	-.13	-.25	.16	.47*	-242.3453	-1.982

* Significant at the 5% level

** Significant at the 1% level

TABLE 3. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Pergamino, ARGENTINA, 1963.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to flowering	Height cms.	Lodging $\sqrt{\% + 1}$	Leaf rust	Fusarium %
Carazinho	Brazil	22	3012	81.7	38.0	85	128	1.00	T VR	0
Buck Atlantico	Argentina	17	2987	80.6	28.0	88	121	1.00	40 S	0
Magnif 41	Argentina	16	2808	78.2	38.0	80	126	1.00	0	10
Nainari 60	Mexico	14	2744	76.4	40.0	83	114	1.00	0	50
Mayo 64	Mexico	18	2718	73.9	26.0	83	99	1.00	T VR	1
Gaboto	Argentina	1	2702	83.1	30.0	85	120	1.00	0	1
Tacuari	Argentina	2	2656	81.1	28.0	86	119	1.00	0	5
Penjamo 62	Mexico	24	2432	77.3	34.0	80	97	1.00	T VR	0
Gabo	Australia	13	2188	71.9	30.0	82	108	1.00	0	20
North Dakota #81	U.S.A.	6	2186	79.5	30.0	87	117	1.00	0	2
Crim	U.S.A.	3	2179	78.6	26.0	93	123	1.00	T VR	5
Magnif 42	Argentina	4	2134	83.8	32.0	85	116	1.58	10 S	2
Pitic 62	Mexico	10	2133	70.5	26.0	84	110	1.00	80 S	30
Fr-KAD x Gb	Colombia	23	2101	72.8	36.0	72	103	1.00	100 S	0
Nariño 59	Colombia	12	2074	75.9	28.0	78	117	1.00	20 MS	5
Bonza 55	Colombia	15	2009	74.6	38.0	82	116	1.00	60 S	20
Selkirk	Canada	11	1762	73.7	24.0	100	125	3.28	0	10
Lerma Rojo	Mexico	9	1751	79.5	36.0	80	120	1.00	80 S	40
Giza 144	Egypt	7	1647	75.5	28.0	86	123	1.00	T VR	20
Sonora 64	Mexico	20	1505	73.0	28.0	73	92	1.00	T VR	5
Double Insignia	Australia	21	1500	69.2	24.0	90	103	1.00	100 S	15
Justin	U.S.A.	8	1478	73.4	22.0	101	123	1.00	10 MR	3
Lerma Rojo 64 A	Mexico	19	1398	75.5	28.0	77	101	1.00	100 S	25
C-271	Pakistan	25	1247	68.3	28.0	80	102	1.00	90 S	10
Thatcher	U.S.A.	5	916	75.2	20.0	100	118	2.70	90 S	5
Statistical level of significance			0.5%	(only	(only	(only	0.5%	NS	(only	(only
Coefficient of variation			14.3%	1 rep.)	1 rep.)	1 rep.)	3.1%	82.5%	1 rep.)	1 rep.)
Efficiency of lattice			101%				134%	RB		
Mean			2091	76.1	29.8	85	114	1.18	4.26[1]	3.05[1]
Comparison std. error (ave.)			215.7				2.8	—		
Least significant difference, 5%			432.0				5.6	—		

[1] Mean of data transformed $\sqrt{X+1}$

TABLE 4. Correlations between the means of 8 variables and the multiple regression of yield on the means of 7 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Pergamino, ARGENTINA, 1963.

	Correlations (r); d. f. = 23							Multiple Regression $R^2 = .628$ 7 "independent" variables constant term = -1326.510	
	Yield	Test wt.	1000 grain wt.	Days to flowering	Height	Lodging $\sqrt{\% + 1}$	Leaf rust $\sqrt{X + 1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 17
Test wt.	.57**							23.4459	.761
1000 grain wt.	.54**	.35						45.2818	1.751
Days to flowering	-.20	.05	-.59**					6.0851	.259
Height	.27	.54**	.08	.55**				4.0558	.279
Lodging $\sqrt{\% + 1}$	-.35	-.05	-.40*	.60**	.25			-250.1106	-1.313
Leaf rust $\sqrt{X + 1}$	-.52**	-.43*	-.12	-.15	-.29	.02		-45.5877	-1.782
Fusarium $\sqrt{\% + 1}$	-.26	-.33	.18	-.11	-.01	-.05	.27	-67.5407	-1.185

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 5. Yield and agronomic data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Encarnación, PARAGUAY, 1964.

Variety or cross	Origin	Variety number	Yield kg./ha.	1000 grain weight gms.	Days to: flowering	Days to: maturity	Height cms.
Buck Atlantico	Argentina	17	2605	28.6	82	131	102
North Dakota #81	U.S.A.	6	2450	29.6	78	131	98
Pitic 62	Mexico	10	2420	26.6	78	130	96
Gaboto	Argentina	1	2414	27.2	80	132	94
Nainari 60	Mexico	14	2356	26.3	80	130	101
Tacuari	Argentina	2	2324	29.2	76	129	104
Lerma Rojo	Mexico	9	2316	41.6	69	112	104
Penjamo 62	Mexico	24	2247	32.0	72	112	79
Gabo	Australia	13	2206	29.6	76	130	93
Lerma Rojo 64 A	Mexico	19	2193	32.1	66	112	86
Magnif 42	Argentina	4	2180	32.5	80	128	104
Magnif 41	Argentina	16	2177	40.5	72	112	112
Giza 144	Egypt	7	2160	32.6	78	126	99
Nariño 59	Colombia	12	2108	37.6	66	119	89
Carazinho	Brazil	22	2067	39.1	80	131	118
Fr-KAD x Gb	Colombia	23	1848	34.6	58	105	76
Bonza 55	Colombia	15	1735	31.8	76	123	110
C-271	Pakistan	25	1718	28.5	74	119	96
Sonora 64	Mexico	20	1706	25.1	58	107	74
Crim	U.S.A.	3	1605	30.3	91	139	105
Double Insignia	Australia	21	1556	26.0	88	136	82
Mayo 64	Mexico	18	1469	25.4	72	124	88
Thatcher	U.S.A.	5	926	20.9	116	159	106
Selkirk	Canada	11	873	22.5	111	156	103
Justin	U.S.A.	8	825	28.9	112	154	101
Statistical level of significance			0.5%	0.5%	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			11.6%	11.4%			
Efficiency of lattice			108%	105%			
Mean			1939	30.8	80	127	97
Comparison std. error (ave.)			169.9	2.60			
Least significant difference, 5%			340.3	5.21			

TABLE 6. Correlations between the means of 5 variables and the multiple regression of yield on 4 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Encarnación PARAGUAY, 1964.

Correlation (r); d. f. = 23

Multiple Regression: $R^2 = .589$; 4 "independent" variables; constant term = 405.652

	Yield	1000 grain wt.	Days to flowering	Days to maturity	Partial regression coef. (b)	"t" d.f. = n-k-1 = 20
1000 grain wt.	.50**				17.4637	.789
Days to flowering	-.65**	-.49*			-53.7845	-3.048**
Days to maturity	-.57**	-.55**	.96**		33.4123	1.654
Height	-.01	.26	.45*	.45*	10.4989	1.077

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 7. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at La Platina, Provincia de Santiago, CHILE, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to flowering	Height cms.	Stem rust	Leaf rust	Stripe rust leaf	Stripe rust head(%)[1]
Nariño 59	Colombia	12	4796	82.1	40.4	92	115	0	0	0	25
Lerma Rojo 64 A	Mexico	19	4413	84.4	45.1	93	97	T R	0	0	0
Tacuari	Argentina	2	4208	83.1	32.3	99	122	0	0	T R	0
Magnif 42	Argentina	4	4057	82.9	42.0	99	117	t R	5 R	5 S	35
Double Insignia	Australia	21	4047	80.9	41.6	100	102	70 S	0	0	35
Pitic 62	Mexico	10	4000	76.3	36.4	99	97	0	50 MS	0	0
Lerma Rojo	Mexico	9	3999	83.2	45.0	95	127	T MS	10 MR	0	0
Gaboto	Argentina	1	3955	84.5	33.4	101	127	0	0	T R	1
Selkirk	Canada	11	3852	77.3	32.6	109	137	0	30 MS	0	0
Penjamo 62	Mexico	24	3732	82.8	39.9	94	90	0	T MR	0	8
Carazinho	Brazil	22	3700	82.6	44.5	100	120	15 MS-S	0	0	0
Nainari 60	Mexico	14	3654	80.1	45.5	93	100	T R	0	15 S	0
Fr-KAD x Gb	Colombia	23	3336	81.7	37.9	89	92	10 MS-S	60 S	T R	0
Bonza 55	Colombia	15	3297	78.8	36.0	94	117	0	T MS	0	1
Crim	U.S.A.	3	3228	79.4	35.1	98	125	T R	0	30 S	8
C-271	Pakistan	25	3191	80.1	41.8	89	95	80 S	80 S	T R	60
Magnif 41	Argentina	16	3178	81.5	44.5	94	125	T R	0	T R	0
North Dakota #81	U.S.A.	6	3139	79.5	35.3	99	107	5 R-MR	0	20 S	0
Mayo 64	Mexico	18	3101	75.4	32.8	95	95	5 R-MR	30 S	30 S	15
Justin	U.S.A.	8	3020	78.7	32.0	106	117	10 MR-MS	0	0	5
Buck Atlantico	Argentina	17	2772	80.0	28.7	101	112	40 MS-S	0	0	0
Giza 144	Egypt	7	2366	78.3	40.5	98	120	T MS	0	0	0
Thatcher	U.S.A.	5	2242	77.1	24.8	113	125	T R	80 S	0	0
Sonora 64	Mexico	20	2239	72.8	29.0	90	82	T R	0	60 S	99
Gabo	Australia	13	1824	75.5	34.9	93	87	0	0	40 S	3
Statistical level of significance			0.5%	0.5%	0.5%	(only	(only	(only	(only	(only	(only
Coefficient of variation			15.3%	1.5%	6.8%	1 rep.)	1 rep.)	1 rep.)	1 rep.)	1 rep.	1 rep.)
Efficiency of lattice			109%	101%	RB						
Mean			3414	80.0	37.3	97	110	2.36[2]	2.57[2]	2.26[2]	2.60[2]
Comparison std. error (ave.)			394.7	.89	1.79						
Least significant difference, 5%			790.6	1.78	3.59						

[1] Data were often reported as a range, but only the mean of the range is presented. Traces were analyzed as 1%

[2] Mean of coefficients transformed $\sqrt{X+1}$

TABLE 8. Correlations between the means of 9 variables and the multiple regression of yield on 8 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at La Platina, Provincia de Santiago, CHILE, 1963-64.

	Correlations (r); d.f. = 23								Multiple Regression R^2 = .601; 8 "independent" variables; constant term = -9050.189	
	Yield	Test wt.	1000 grain wt.	Days to flowering	Height	Stem rust $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Stripe rust, leaf, $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 16
Test wt.	.69**								132.1381	2.075
1000 grain wt.	.50**	.56**							26.0628	.872
Days to flowering	-.07	-.10	-.50**						9.0191	.260
Height	.22	.32	-.16	.67**					1.6779	.132
Stem rust $\sqrt{X+1}$	-.06	.08	.07	-.06	-.10				-89.4327	-1.559
Leaf rust $\sqrt{X+1}$	-.15	-.28	-.24	.11	-.14	.21			13.5948	.266
Stripe rust, leaf, $\sqrt{X+1}$	-.49*	-.59**	-.26	-.31	-.45*	-.22	-.16		-94.7847	-1.007
Stripe rust, head, $\sqrt{\%+1}$	-.06	-.27	-.03	-.36	-.43*	.33	.05	.40*	98.1319	1.639

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 9. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Quito, ECUADOR, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to flowering	Height cms.	Stem rust	Leaf rust	Stripe rust leaf	Stripe rust head(%)	Septoria %
Magnif 41	Argentina	16	3893	74.3	44.4	72	120	0	0	20 MS	1	0
Tacuari	Argentina	2	3830	74.0	29.7	85	120	0	0	10 MR	0	10
Gaboto	Argentina	1	3738	73.0	33.2	90	132	0	T R	5 MR	0	0
Fr-KAD x Gb	Colombia	23	3578	66.3	39.1	67	85	0	T MS	15 S	1	0
C-271	Pakistan	25	3443	70.8	45.3	74	85	T R	T MS	T MR	0	5
Pitic 62	Mexico	10	3267	69.3	33.8	91	85	0	T MS	40 S	0	5
Bonza 55	Colombia	15	3062	74.3	36.7	80	120	T MS	5 MS	10 MS	0	5
Selkirk	Canada	11	2972	73.5	37.2	97	130	0	30 S	T R	0	0
Double Insignia	Australia	21	2737	68.5	34.2	86	85	0	5 MS	0	0	10
Penjamo 62	Mexico	24	2150	63.0	37.7	74	85	0	T MS	60 S	1	0
Nariño 59	Colombia	12	2137	65.8	36.4	72	100	T MS	0	40 S	5	0
Justin	U.S.A.	8	2135	69.3	28.2	96	110	0	T MS	15 S	0	5
Magnif 42	Argentina	4	1987	74.0	34.7	86	105	0	0	20 S	0	10
Carazinho	Brazil	22	1490	55.8	31.8	95	130	0	0	50 S	5	0
Lerma Rojo	Mexico	9	1343	56.8	35.1	76	100	0	5 MS	70 MS	5	0
Nainari 60	Mexico	14	1235	66.0	33.9	80	90	T MS	5 MS	50 S	0	0
Buck Atlantico	Argentina	17	1087	62.3	29.5	94	130	0	T MS	5 MR	1	20
Mayo 64	Mexico	18	725	55.5	35.9	76	85	0	0	30 S	1	10
Thatcher	U.S.A.	5	665	61.3	26.2	102	130	0	5 MS	40 S	5	5
North Dakota #81	U.S.A.	6	533	56.0	23.4	82	90	0	T R	30 S	5	0
Lerma Rojo 64 A	Mexico	19	465	47.0	29.8	70	85	0	0	90 S	30	0
Giza 144	Egypt	7	455	51.5	35.1	82	100	0	T MS	20 MS	30	0
Crim	U.S.A.	3	280	39.3	15.0	76	110	0	0	50 MS	1	0
Gabo	Australia	13[1/]	120	—	—	74	80	0	0	60 S	20	5
Sonora 64	Mexico	20[1/]	53	—	—	67	60	0	0	60 S	50	-
Statistical level of significance			0.5%	0.5%	0.5%	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			20.1%	3.6%	5.9%							
Efficiency of lattice			RB	RB	RB							
Mean			2052	63.8	33.3	83	105	1.07[2/]	1.63[2/]	4.75[2/]	1.82[2/]	1.87[2/]
Comparison std. error (ave.)			292	1.62	1.39							
Least significant difference, 5%			584	3.24	2.78							

1/ Due to the extremely low yields, data for varieties 13 and 20 were not analyzed for any trait nor were they included in the correlations or multiple regression.

2/ Mean of either the coefficient or percentage transformed $\sqrt{X+1}$

TABLE 10. Correlations between the means of 10 variables and the multiple regression of yield on the mean of 9 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Quito, ECUADOR, 1963-64.

Correlations (r); d.f. = 21

Multiple Regression: R^2 = .859; 9 "independent" variables; constant term = 706.824

	Yield	Test wt.	1000 grain wt.	Days to flowering	Height	Stripe rust, head, $\sqrt{\%+1}$	Stem rust $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Stripe rust, leaf, $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 13
Test wt.	.84**									93.1368	3.244**
1000 grain wt.	.60**	.59**								17.8062	.515
Days to flowering	-.04	.22	-.33							-24.3275	-1.005
Height	.13	.22	-.20	.62**						1.8086	.181
Stripe rust, head $\sqrt{\%+1}$	-.58**	-.63**	-.14	-.20	-.16					-174.6379	-1.203
Stem rust $\sqrt{X+1}$	.16	.26	.34	-.30	-.16	-.16				-1353.4059	-1.464
Leaf rust $\sqrt{X+1}$	.13	.28	.14	.38	.25	-.19	.04			-204.8594	-1.176
Stripe rust, leaf $\sqrt{X+1}$	-.57**	-.60**	-.27	-.29	-.33	.47*	-.05	-.31		-137.3935	-1.725
Septoria $\sqrt{\%+1}$	.08	.30	-.04	.36	.09	-.37	-.06	-.12	-.46*	-327.3240	-1.971

* = Significant at the 5% level

** = Significant at the 1% level

1/ Data from varieties 13 and 20 were not included in either the correlations or the multiple regression.

TABLE 11. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Quezaltenango, GUATEMALA, 1963.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to: flowering	Days to: maturity	Height cms.	Rust note leaf (X̄)	Rust note stripe	Septoria
Pitic 62	Mexico	10	4457	63.0	30.0	81	150	90	0	0	1
Selkirk	Canada	11	3803	68.6	38.0	82	146	110	0	0	1
Nainari 60	Mexico	14	3596	63.6	31.0	74	140	90	0	15 S	2
Nariño 59	Colombia	12	3586	71.1	36.0	63	138	90	0	0	1
Bonza 55	Colombia	15	3537	67.3	29.0	81	148	105	0	0	1
Penjamo 62	Mexico	24	3346	64.9	29.0	66	132	80	0	T	2
Buck Atlantico	Argentina	17	3131	66.1	27.0	84	152	110	8 S	T	1
Fr-KAD x Gb	Colombia	23	3089	69.8	35.0	55	132	85	75 S	0	1
Carazinho	Brazil	22	2953	66.1	33.0	87	159	115	0	15 S	1
Gaboto	Argentina	1	2912	68.6	27.0	83	150	105	0	40 S	1
C-271	Pakistan	25	2878	67.3	34.0	69	136	85	50 S	0	2
Tacuari	Argentina	2	2870	71.7	26.0	73	142	95	0	20 S	1
Magnif 42	Argentina	4	2663	68.6	29.0	83	154	100	0	80 S	1
Justin	U.S.A.	8	2542	54.3	23.0	87	154	105	35 S	0	1
Giza 144	Egypt	7	2531	67.3	30.0	73	138	100	0	40 S	1
Lerma Rojo 64 A	Mexico	19	2499	71.1	31.0	63	132	75	T	30 MS	2
North Dakota #81	U.S.A.	6	2414	65.5	28.0	69	142	90	0	5 S	1
Mayo 64	Mexico	18	2317	61.1	25.0	65	136	80	0	60 S	2
Crim	U.S.A.	3	2248	64.9	27.0	72	142	100	0	5 S	3
Lerma Rojo	Mexico	9	2066	71.1	34.0	65	130	95	50 S	T	2
Thatcher	U.S.A.	5	2054	63.6	22.0	83	148	105	100 S	T	1
Double Insignia	Australia	21	2028	54.9	22.0	83	148	85	5 MS	70 MS	1
Gabo	Australia	13	1222	59.9	24.0	71	130	70	0	40 MS	3
Magnif 41	Argentina	16	1139	61.1	26.0	63	130	90	0	90 S	3
Sonora 64	Mexico	20	1048	1/	21.0	60	130	65	0	100 S	2
Statistical level of significance			0.5%	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			8.8%								
Efficiency of lattice			103%								
Mean			2677	65.7	28.7	73	142	93	2.49 2/	3.90 2/	1.52
Comparison std. error (ave.)			172.7								
Least significant difference, 5%			345.9								

1/ Not enough seed to take data. A value of 71.1 was substituted for the correlations and multiple regression.
2/ Mean of the rust coefficients transformed to $\sqrt{X+1}$

TABLE 12. Correlations between the means of 9 variables and the multiple regression of yield on the means of 8 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Quezaltenango, GUATEMALA, 1963.

Correlations (r); d.f. = 23

Multiple Regression
R^2 = .813
8 "independent" variables
constant term = -820.543

	Yield	Test wt.	1000 grain wt.	Days to flowering	Days to maturity	Height	Leaf rust, $\sqrt{X+1}$	Stripe rust, $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f.=n-k-1=16
Test wt.	.22								-4.7667	-.178
1000 grain wt.	.61**	.54**							78.9174	2.665*
Days to flowering	.30	-.38	-.18						4.6195	.165
Days to maturity	.42*	-.24	-.07	.92**					29.6519	.894
Height	.41*	.01	.23	.73**	.77**				-18.1178	-1.314
Leaf rust $\sqrt{X+1}$	-.10	-.03	.05	-.06	-.06	.11			-101.3090	-2.543*
Stripe rust $\sqrt{X+1}$	-.62**	-.10	-.49*	-.14	-.18	-.37	-.44*		-139.8445	-3.421**
Septoria	-.55**	-.15	-.18	-.50**	-.66**	-.53**	-.14	.29	-335.4356	-1.673

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 13. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at El Roque, Guanajuato, MEXICO, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Days to: flowering	Days to: maturity	Height cms.	Lodging %	Shattering %	Stem rust	Leaf rust	Stripe rust
Pitic 62	Mexico	10	4900	87	129	95	0	0	40 S	5 R	50 S
Bonza 55	Colombia	15	4504	84	124	110	60	0	0	5 R	0
Nariño 59	Colombia	12	4492	81	122	110	60	5	0	T R	10 MS
Tacuari	Argentina	2	4420	86	128	120	0	0	0	T R	5 MS
Nainari 60	Mexico	14	4379	86	126	100	0	0	10 MR	5 R	40 S
Lerma Rojo 64 A	Mexico	19	4253	81	127	100	0	0	10 S	0	90 S
C-271	Pakistan	25	4185	77	119	110	40	0	30 S	0	10 MS
North Dakota #81	U.S.A.	6	4025	89	131	110	10	0	T R	T R	40 S
Lerma Rojo	Mexico	9	3998	81	123	130	40	0	T S	T R	50 S
Buck Atlantico	Argentina	17	3944	91	131	120	0	0	0	T R	20 MS
Gaboto	Argentina	1	3912	94	131	120	40	0	0	0	10 MS
Magnif 42	Argentina	4	3912	89	131	115	0	0	0	T R	20 MS
Mayo 64	Mexico	18	3883	84	124	100	0	0	10 MR	5 MR	40 S
Penjamo 62	Mexico	24	3817	80	121	95	0	1	T S	0	80 S
Carazinho	Brazil	22	3705	93	133	130	0	0	5 R	5 R	60 S
Crim	U.S.A.	3	3630	89	128	110	0	0	0	T R	50 S
Giza 144	Egypt	7	3555	84	131	120	10	0	0	5 R	50 S
Magnif 41	Argentina	16	3543	79	119	130	40	0	0	0	50 S
Double Insignia	Australia	21	3363	86	128	100	0	0	20 S	0	90 S
Fr-KAD x Gb	Colombia	23	3313	70	112	100	0	0	0	0	0
Sonora 64	Mexico	20	3290	72	112	60	0	0	T S	0	70 S
Gabo	Australia	13	3222	84	124	85	0	0	5 R	5 R	70 S
Justin	U.S.A.	8	3127	101	136	130	0	0	T R	T R	0
Selkirk	Canada	11	3030	104	134	130	0	5	0	40 MR	0
Thatcher	U.S.A.	5	2207	100	140	130	20	0	0	5 S	80 S
Level of significance			0.5%	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			8.4%								
Efficiency of lattice			RB								
Mean			3784	86	127	110	2.74[1/]	1.13[1/]	1.85[1/]	1.44[1/]	5.60[1/]
Comparison std. error (ave.)			225.5								
Least significant difference, 5%			451.7								

[1/] Mean of either the percentage or the coefficient transformed $\sqrt{X+1}$

TABLE 14. Correlations between the means of 9 variables and the multiple regression of yield on the means of 8 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at El Roque, Guanajuato, MEXICO, 1963-64.

Correlations (r); d. f. = 23

Multiple Regression
R^2 = .463
8 "independent" variables
constant term = -61.1532

	Yield	Days to flowering	Days to maturity	Height	Lodging $\sqrt{\%+1}$	Shattering $\sqrt{\%+1}$	Stem rust $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f.=n-k-1=16
Days to flowering	-.32								-65.6877	-1.375
Days to maturity	-.22	.93**							80.2047	1.463
Height	-.15	.60**	.61**						-4.0399	-.384
Lodging $\sqrt{\%+1}$	.19	-.14	-.14	.33					14.6759	.281
Shattering $\sqrt{\%+1}$	-.01	.20	.03	.13	.17				454.4215	1.218
Stem rust $\sqrt{X+1}$	.37	-.18	-.09	-.30	-.10	-.18			128.1473	1.658
Leaf rust $\sqrt{X+1}$	-.38	.65**	.49*	.38	-.11	.59**	-.21		-362.4177	-1.235
Stripe rust $\sqrt{X+1}$	-.16	-.18	.00	-.34	-.24	-.32	.24	-.24	-84.5416	-1.859

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 15. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at CIANO, Ciudad Obregon, Sonora, MEXICO, from an earlier than normal planting date, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to flowering	Days to maturity	Height cms.	Lodging $\sqrt{\% + 1}$	"Leaf firing"
Nainari 60	Mexico	14	4544	78.5	39.5	87	154	123	3.05	1
Mayo 64	Mexico	18	4377	76.7	37.0	64	137	96	2.69	2
Magnif 41	Argentina	16	4255	79.5	44.6	66	137	113	7.34	1
Gabo	Australia	13	4238	75.8	37.4	74	137	115	4.41	1
Pitic 62	Mexico	10	4066	78.0	38.0	97	161	111	2.33	1
Lerma Rojo 64 A	Mexico	19	3583	78.9	41.4	83	137	98	7.21	1
C-271	Pakistan	25	3522	76.0	40.0	75	141	123	7.73	2
Giza 144	Egypt	7	3450	81.7	42.4	84	154	120	8.87	2
Penjamo 62	Mexico	24	3411	78.5	38.3	60	137	85	4.83	1
North Dakota #81	U.S.A	6	3380	79.2	35.2	72	140	116	4.04	1
Lerma Rojo	Mexico	9	3305	78.5	37.6	66	137	116	9.66	2
Double Insignia	Australia	21	3258	75.3	36.2	100	163	119	5.13	1
Carazinho	Brazil	22	3211	79.3	41.0	102	162	126	8.42	1
Gaboto	Argentina	1	3097	80.4	32.8	104	1/	125	8.10	1
Bonza 55	Colombia	15	2952	76.8	34.4	74	140	123	6.17	2
Crim	U.S.A.	3	2925	79.2	37.4	104	153	128	7.90	2
Selkirk	Canada	11	2758	75.9	37.0	131	1/	1/	1/	1
Nariño 59	Colombia	12	2650	76.9	37.4	57	112	104	6.39	2
Justin	U.S.A.	8	2514	76.6	34.0	1/	1/	1/	1/	1
Tacuari	Argentina	2	2458	78.6	31.0	69	138	108	7.48	3
Sonora 64	Mexico	20	2361	71.8	30.4	53	115	79	1.00	1
Buck Atlantico	Argentina	17	2344	78.4	30.8	85	147	120	7.72	4
Magnif 42	Argentina	4	2308	81.9	37.0	77	150	113	9.18	2
Fr-KAD x Gb	Colombia	23	2183	75.3	37.4	50	101	88	1.00	2
Thatcher	U.S.A.	5	1725	71.7	26.2	1/	1/	1/	1/	1
Statistical level of significance			0.5%	(only 1 rep.)	(only 1 rep.)	0.5%	0.5%	0.5%	0.5%	(only 1 rep.)
Coefficient of variation			14.9%			2.8%	2.1%	5.5%	25.6%	
Efficiency of lattice			RB			RB	RB	RB	RB	
Mean			3275	77.8	37.4	75	141	111	5.83	1.7
Comparison std. error (ave.)			333			1.6	2.0	4.3	1.07	
Least significant difference, 5%			667			3.2	4.0	8.6	2.14	

1/ Data were not recorded due to extreme lateness of the variety.

TABLE 16. Correlations between the means of 8 variables and the multiple regression of yield on the means of 7 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at CIANO, Ciudad Obregon, Sonora, MEXICO from an earlier than normal planting date, 1963-64.[1]

Correlations (r); d. f. = 23

Multiple Regression: R^2 = .807; 7 "independent" variables; constant term = -1890.946

	Yield	Test wt.	1000 grain wt.	Days to flowering	Days to maturity	Height	Lodging $\sqrt{\%+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 17
Test wt.	.11							-80.6486	-1.244
1000 grain wt.	.59**	.44*						129.5550	3.442**
Days to flowering	.20	.34	.14					-57.2148	-3.589**
Days to maturity	.37	.51**	.23	.89**				60.1572	3.963**
Height	.21	.46*	.22	.77**	.70**			31.1990	2.496*
Lodging $\sqrt{\%+1}$	-.16	.66**	.27	.29	.39*	.57**		-189.4399	-3.405**
"Leaf firing"	-.54**	.15	-.48*	-.04	-.10	.17	.37	59.4662	.333

* = Significant at the 5% level

** = Significant at the 1% level

[1] Data were not used for Varieties 1, 5, 8 and 11 in either the correlations or the multiple regression analysis.

TABLE 17. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at CIANO, Ciudad Obregon, Sonora, MEXICO, normal planting date, 1963-64.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to: flowering	Days to: maturity	Height cms.	Lodging $\sqrt{\%+1}$	Leaf rust	"Leaf firing"
Pitic 62	Mexico	10	5484	76.5	35.6	94	153	103	1.00	50 S	1
Penjamo 62	Mexico	24	5442	81.7	41.9	74	139	96	3.69	5 MR	3
Lerma Rojo 64 A	Mexico	19	5317	81.6	41.0	76	143	108	4.22	0	2
Mayo 64	Mexico	18	4992	76.7	34.5	83	138	108	1.00	5 S	2
C-271	Pakistan	25	4744	81.7	44.5	83	147	124	6.21	40 S	2
Nainari 60	Mexico	14	4559	78.2	38.5	92	150	116	1.36	20 S	1
Lerma Rojo	Mexico	9	4550	81.8	41.3	79	137	123	9.32	80 S	1
Gabo	Australia	13	4208	77.8	37.6	87	142	119	3.65	30 S	1
North Dakota #81	U.S.A.	6	3942	80.1	34.7	87	151	121	3.43	5 MS	2
Double Insignia	Australia	21	3875	80.2	40.6	103	158	106	3.26	90 S	1
Tacuari	Argentina	2	3567	80.3	32.0	84	145	119	8.53	0	3
Fr-KAD x Gb	Colombia	23	3433	77.7	41.4	55	125	95	1.94	80 S	2
Magnif 41	Argentina	16	3408	79.8	39.7	83	130	122	9.47	0	1
Carazinho	Brazil	22	3342	79.7	41.8	110	169	114	6.27	0	1
Sonora 64	Mexico	20	3300	78.9	41.7	57	123	84	1.50	0	2
Gaboto	Argentina	1	3275	80.0	32.9	115	166	112	6.19	0	1
Buck Atlantico	Argentina	17	3008	79.8	31.5	98	157	123	6.11	0	2
Giza 144	Egypt	7	2983	82.2	40.4	91	152	126	7.38	65 S	2
Justin	U.S.A.	8	2933	1/	1/	2/	2/	2/	2/	T R	0
Bonza 55	Colombia	15	2725	77.8	34.0	89	153	123	7.87	5 MR	2
Selkirk	Canada	11	2542	1/	1/	2/	2/	2/	2/	20 S	0
Crim	U.S.A.	3	2508	80.3	37.3	106	158	114	7.23	T R	1
Nariño 59	Colombia	12	2467	80.0	36.3	68	137	116	9.39	T R	3
Thatcher	U.S.A	5	2308	1/	1/	2/	2/	2/	2/	80 S	1
Magnif 42	Argentina	4	2192	82.2	36.2	98	161	116	9.53	5 S	1
Statistical level of significance			0.5%	(only 1 rep.)	(only 1 rep.)	0.5%	0.5%	0.5%	0.5%	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			14.8%			2.7%	2.4%	5.9%	25.2%		
Efficiency of lattice			RB			RB	RB	RB	RB		
Mean			3787	79.8	38.0	87	147	113	5.39	3.62 3/	1.7
Comparison std. error (ave.)			397			1.6	2.5	4.7	.96		
Least significant difference, 5%			795			3.2	5.0	9.4	1.92		

1/ Not enough seed was available for taking data.
2/ Data were not recorded due to extreme lateness of the variety.
3/ Mean of coefficient transformed $\sqrt{X+1}$

TABLE 18. Correlations between the means of 9 variables and the multiple regression of yield on the means of 8 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at CIANO, Ciudad Obregon, Sonora, MEXICO, normal planting date, 1963-64.

Correlations (r); d. f. = 23

Multiple Regression: R^2 = .519; 8 "independent" variables; constant term = -7913.340

	Yield	Test wt.	1000 grain wt.	Days to flowering	Days to maturity	Height	Lodging $\sqrt{\%+1}$	Leaf rust $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f.=n-k-1=16
Test wt.	-.15								142.5434	.760
1000 grain wt.	.30	.33							59.0413	.709
Days to flowering	-.19	.09	-.36						43.9238	.873
Days to maturity	-.23	.18	-.33	.93**					-54.8185	-1.071
Height	-.26	.30	-.29	.45*	.41				29.7950	1.078
Lodging $\sqrt{\%+1}$	-.59**	.59**	-.13	.20	.20	.64**			-305.1768	-2.725*
Leaf rust $\sqrt{X+1}$	.27	-.03	.42*	-.10	-.11	.01	-.23		11.5657	.149
"Leaf firing"	.03	.15	-.10	-.57**	-.39	-.14	.05	-.28	338.1459	.700

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 19. Yield and agronomic data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Davis, California, U.S.A., 1963-64[1]

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight gms.	Days to flowering	Height cms.	Lodging $\sqrt{\% + 1}$
Penjamo 62	Mexico	24	5079	73.3	39.1	117	94	1.14
Sonora 64	Mexico	20	4672	76.1	36.9	113	80	1.00
Bonza 55	Colombia	15	4654	73.9	35.0	119	115	1.76
C-271	Pakistan	25	4573	75.7	40.2	115	104	1.55
Double Insignia	Australia	21	4481	75.6	40.0	121	96	1.02
Mayo 64	Mexico	18	4385	73.1	37.4	122	98	1.00
Lerma Rojo	Mexico	9	4228	74.0	38.0	118	121	2.24
Giza 144	Egypt	7	4197	74.9	36.4	122	117	2.62
Fr-KAD x Gb	Colombia	23	4077	72.3	34.2	114	103	1.10
Nainari 60	Mexico	14	4058	73.2	40.5	117	104	1.11
North Dakota #81	U.S.A.	6	4029	75.1	33.3	125	116	1.90
Nariño 59	Colombia	12	4016	75.1	34.5	121	124	2.33
Magnif 42	Argentina	4	3994	78.3	35.8	120	116	3.11
Pitic 62	Mexico	10	3924	66.8	30.7	122	95	1.00
Gabo	Australia	13	3898	72.2	37.4	116	102	1.05
Tacuari	Argentina	2	3838	75.9	28.2	124	122	3.40
Lerma Rojo 64 A	Mexico	19	3665	74.3	34.4	119	100	1.04
Buck Atlantico	Argentina	17	3626	77.3	32.3	125	118	1.52
Magnif 41	Argentina	16	3575	73.1	37.7	118	129	3.89
Crim	U.S.A.	3	3330	75.3	33.5	122	122	2.42
Gaboto	Argentina	1	3266	76.1	26.9	123	123	2.11
Carazinho	Brazil	22	2915	71.6	34.6	123	118	2.36
Thatcher	U.S.A.	5	2624	73.4	26.7	132	124	7.00
Justin	U.S.A.	8	2635	75.3	27.9	132	127	4.07
Selkirk	Canada	11	2604	71.6	30.9	132	120	3.65
Statistical level of significance			0.5%	0.5%	0.5%	0.5%	0.5%	0.5%
Coefficient of variation			8.6%	1.1%	5.2%	0.7%	2.5%	32.0%
Efficiency of lattice			107%	103%	107%	122%	110%	113%
Mean			3862	74.2	34.6	121	112	2.21
Comparison std. error (ave.)			248.7	.62	1.36	.6	2.1	.539
Least significant difference, 5%			498.1	1.24	2.72	1.2	4.2	1.079

[1] Ramona, a widely seeded local variety, was also included for comparison and yielded 3546 kg./ha.

TABLE 20. Correlations between the means of 6 variables and the multiple regression of yield on the means of 5 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Davis, California, U.S.A., 1963-64.

Correlations (r); d. f. = 23

Multiple Regression: R^2 = .706; 5 "independent" variables; constant term = 4434.754

	Yield	Test wt.	1000 grain wt.	Days to flowering	Height	Partial regression coef. (b)	"t" d.f. = n-k-1 = 19
Test weight	.14					64.2382	1.563
1000 grain wt.	.71**	.02				43.6785	1.408
Days to flowering	-.75**	-.02	-.74**			-40.8630	-1.570
Height	-.64**	.20	-.50**	.57**		-16.5103	-1.763
Lodging $\sqrt{\%+1}$	-.65**	.08	-.59**	.68**	.71**	-23.2715	-.248

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 21. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at St. Paul, Minnesota, U.S.A., 1964.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	Days to flowering	Height cms.	Lodging score	Stem rust	Leaf rust
Gabo	Australia	13	1705	64.8	46	75	1.00	60	50
Mayo 64	Mexico	18	1650	63.2	46	70	1.00	5	0
Thatcher	U.S.A.	5	1637	71.6	47	89	1.49	5	30
Justin	U.S.A.	8	1620	71.4	50	90	1.26	T-10	20
Nainari 60	Mexico	14	1592	67.3	47	79	1.00	30	15
Fr-KAD x Gb	Colombia	23	1587	67.3	43	76	1.50	15	0
Lerma Rojo	Mexico	9	1564	72.3	45	83	2.00	T	0
North Dakota #81	U.S.A.	6	1555	71.2	46	75	1.13	T	0
Crim	U.S.A.	3	1552	70.0	47	90	2.25	0	30
Lerma Rojo 64 A	Mexico	19	1475	70.3	44	76	1.37	0	0
Penjamo 62	Mexico	24	1470	71.4	46	72	1.50	T	0
Nariño 59	Colombia	12	1467	71.4	45	85	1.64	T	20
Selkirk	Canada	11	1456	67.7	47	96	1.37	0	30
Pitic 62	Mexico	10	1417	67.4	51	77	1.13	T	20
Magnif 41	Argentina	16	1417	66.3	44	83	2.24	0	0
Sonora 64	Mexico	20	1357	68.7	44	61	.99	5	0
Giza 144	Egypt	7	1221	74.3	48	80	1.02	T	20
Tacuari	Argentina	2	1188	72.6	50	90	1.51	0	0
Double Insignia	Australia	21	1187	70.1	50	65	1.00	5	60
Bonza 55	Colombia	15	1045	69.8	52	92	1.00	0	20
Buck Atlantico	Argentina	17	1022	71.2	53	90	1.01	20	5
C-271	Pakistan	25	1001	68.6	47	77	1.00	70	60
Gaboto	Argentina	1	923	73.2	54	90	1.37	0	0
Carazinho	Brazil	22	883	70.8	54	88	1.01	T	T
Magnif 42	Argentina	4	644	71.5	55	83	.99	60	T
Statistical level of significance			0.5%	0.5%	0.5%	0.5%	0.5%	(only 1 rep.)	(only 1 rep.)
Coefficient of variation			12.8%	1.8%	1.1%	6.1%	17.1%		
Efficiency of lattice			123%	101%	102%	105%	101%		
Mean			1345	69.8	48	81	1.30	2.69[1]	3.26[1]
Comparison standard error (ave.)			133	.92	.4	3.7	.16		
Least significant difference, 5%			266	1.84	.8	7.4	.32		

[1] Mean of coefficient transformed $\sqrt{X+1}$

TABLE 22. Correlations between the means of 7 variables and the multiple regression of yield on the means of 6 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at St. Paul, Minnesota, U.S.A., 1964.

Correlations (r); d.f. = 23

Multiple regression: R^2 = .662; 6 "independent" variables; constant term = 5795.372

	Yield	Test wt.	Days to flowering	Height	Lodging score	Stem rust $\sqrt{X+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 18
Test wt.	-.41*						- 25.727	-1.487
Days to flowering	-.75**	.37					-62.643	-3.463**
Height	-.22	.35	.46*				5.686	.889
Lodging score	.35	.10	-.42*	.31			-61.362	-.394
Stem rust $\sqrt{X+1}$	-.19	-.30	.09	-.21	-.44*		-30.796	-1.518
Leaf rust $\sqrt{X+1}$	.09	-.14	.06	.06	-.19	.33	18.276	1.034

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 23. Yield and test weight data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Fargo, North Dakota, U.S.A., 1964.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.
North Dakota #81	U.S.A.	6	1961	69.2
Magnif 41	Argentina	16	1702	68.9
Lerma Rojo	Mexico	9	1625	70.8
Lerma Rojo 64 A	Mexico	19	1602	71.4
Penjamo 62	Mexico	24	1410	68.0
Tacuari	Argentina	2	1389	70.6
Crim	U.S.A.	3	1355	69.4
Selkirk	Canada	11	1342	63.4
Nainari 60	Mexico	14	1302	58.1
Fr-KAD x Gb	Colombia	23	1278	65.5
Nariño 59	Colombia	12	1276	70.6
Justin	U.S.A.	8	1184	68.4
Gaboto	Argentina	1	1183	71.2
Mayo 64	Mexico	18	1178	57.4
Carazinho	Brazil	22	1151	70.1
Sonora 64	Mexico	20	1133	61.9
Bonza 55	Colombia	15	1088	62.2
Giza 144	Egypt	7	1054	71.1
Pitic 62	Mexico	10	957	57.2
Thatcher	U.S.A.	5	756	62.8
Double Insignia	Australia	21	580	58.6
Buck Atlantico	Argentina	17	570	61.7
Gabo	Australia	13	193	1/
C-271	Pakistan	25	66	1/
Magnif 42	Argentina	4	28	1/
Statistical level of significance			0.5%	0.5%
Coefficient of variation			20.6%	2.2%
Efficiency of lattice			109%	RB
Mean			1231	65.8
Comparison std. error (ave.)			170.7	1.0
Least significant difference, 5%			341.9	2.0

Relation between yield and test weight:
Correlation: r = .55**
Regression: y = -1186.430 36.7097 (x)

1/ Data were not taken due to lack of seed. Data for these three varieties were also not used in the correlation or regression.
** Significant at the 1% level

TABLE 24. Yield, agronomic and disease data of the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery" grown at Winnipeg, Manitoba, CANADA, 1964.

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	Days to maturity	Height cms.	Lodging[1] %	Shattering[1] %	Leaf[1] rust %
Carazinho	Brazil	22	2385	79.8	102	85	22	8	1
North Dakota #81	U.S.A.	6	2279	79.8	98	71	15	1	5
Lerma Rojo 64 A	Mexico	19	2262	79.8	91	59	5	0	3
Nainari 60	Mexico	14	2206	73.6	96	65	5	0	5
Nariño 59	Colombia	12	2197	78.0	94	71	5	52	5
Crim	U.S.A.	3	2147	79.8	96	72	46	2	15
Gaboto	Argentina	1	2035	79.8	99	77	34	43	1
Tacuari	Argentina	2	2021	78.6	98	77	40	1	1
Giza 144	Egypt	7	1882	79.2	100	70	40	1	3
Pitic 62	Mexico	10	1863	71.7	99	64	34	1	30
Penjamo 62	Mexico	24	1841	76.1	94	60	5	1	3
Magnif 41	Argentina	16	1786	79.2	91	72	7	1	1
Bonza 55	Colombia	15	1772	72.3	93	72	7	0	5
Selkirk	Canada	11	1769	71.1	92	72	5	1	40
Lerma Rojo	Mexico	9	1705	79.2	93	65	5	0	60
Fr-KAD x Gb	Colombia	23	1702	72.3	89	63	5	34	5
Justin	U.S.A.	8	1690	77.3	99	79	27	18	5
Double Insignia	Australia	21	1477	69.8	99	61	18	0	25
Mayo 64	Mexico	18	1267	63.6	90	60	4	1	20
Sonora 64	Mexico	20	1246	66.1	82	53	0	1	40
Thatcher	U.S.A.	5	1171	73.6	97	74	27	1	75
Buck Atlantico	Argentina	17	1057	68.6	96	77	22	0	1
Magnif 42	Argentina	4	290	52.4	90	70	13	0	5
Gabo	Australia	13	258	39.9	83	58	30	0	50
C-271	Pakistan	25	123	44.9	81	59	62	0	10
Statistical level of significance			0.5%	(only	0.5%	0.5%			
Coefficient of variation			11.2%	1 rep.)	2.6%	3.8%			
Efficiency of lattice			117%		111%	113%			
Mean			1617	71.5	94	68	4.13[2]	2.08[2]	3.56[2]
Comparison standard error (ave.)			139.4		1.9	2.0			
Least significant difference, 5%			279.2		3.8	4.0			

[1] Data summarized by cooperator

[2] Mean of data transformed $\sqrt{\% + 1}$

TABLE 25. Correlations between the means of 7 variables and the multiple regression of yield on the means of 6 variables for the "4th Inter-American Spring Wheat Yield Nursery" grown at Winnipeg, Manitoba, CANADA, 1964.

Correlations (r); d. f. = 23

Multiple Regression: $R^2 = .87$; 6 "independent" variables; constant term = -2373.829

	Yield	Test wt.	Days to maturity	Height	Lodging $\sqrt{\%+1}$	Shattering $\sqrt{\%+1}$	Partial regression coef. (b)	"t" d.f. = n-k-1 = 18
Test wt.	.92**						48.0906	5.304**
Days to maturity	.66**	.72**					17.8185	.917
Height	.37	.47*	.69**				-14.3286	-1.344
Lodging $\sqrt{\%+1}$	-.21	-.18	.26	.35			-17.8365	-.468
Shattering $\sqrt{\%+1}$	.32	.30	.17	.31	-.03		22.2502	.684
Leaf rust $\sqrt{X+1}$	-.36	-.32	-.28	-.40*	-.08	-.30	-30.3145	-1.102

* = Significant at the 5% level
** = Significant at the 1% level

TABLE 26. Overall means of yield, agronomic and disease data of the 25 varieties in the "4th Inter- American Spring Wheat Yield Nursery, 1963-64. The number of locations from which data were available differed between variables.[1]

Variety or cross	Origin	Variety number	Yield kg./ha.	Test weight kg./hl.	1000 grain weight cms.	Days to: flowering	Days to: maturity	Height cms.	Lodging $\sqrt{\%+1}$	Stripe rust leaf $\sqrt{X+1}$	Stripe rust head $\sqrt{\%+1}$	Stem rust $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Shattering $\sqrt{\%+1}$
Pitic 62	Mexico	10	2963	68.6	30.2	86	130	88	2.24	3.88	1.00	2.24	5.11	1.20
Penjamo 62	Mexico	24	2841	72.8	35.3	77	119	83	2.93	4.80	2.20	1.24	1.40	1.41
Tacuari	Argentina	2	2810	76.4	28.9	84	127	106	4.27	2.61	1.00	1.91	1.77	1.20
Nainari 60	Mexico	14	2745	70.3	37.3	83	127	93	1.89	5.38	1.00	3.80	2.32	1.00
Gaboto	Argentina	1	2671	76.6	29.9	90	133	107	4.35	3.18	1.20	2.36	1.09	3.81
Nariño 59	Colombia	12	2647	73.7	34.4	76	122	100	4.71	2.84	3.76	1.31	2.39	4.86
Lerma Rojo 64 A	Mexico	19	2533	72.7	33.4	76	120	87	2.90	6.26	3.28	1.54	2.91	1.00
Bonza 55	Colombia	15	2517	32.4	32.4	83	127	105	4.37	1.49	1.20	1.08	3.22	1.00
Magnif 41	Argentina	16	2512	73.3	37.7	78	118	108	4.80	5.55	1.20	1.54	1.30	1.20
Fr-KAD x Gb	Colombia	23	2504	72.1	35.8	68	112	86	2.44	1.85	1.20	2.03	5.65	3.45
North Dakota #81	U.S.A.	6	2503	73.0	30.7	84	129	97	2.90	4.74	1.72	1.39	1.38	1.20
C-271	Pakistan	25	2497	68.6	35.5	78	120	92	4.77	1.70	4.40	6.15	6.12	1.00
Lerma Rojo	Mexico	9	2486	73.7	37.5	78	119	104	4.71	4.27	1.72	1.32	5.47	1.00
Mayo 64	Mexico	18	2392	66.3	30.2	80	122	86	1.65	6.33	2.70	1.82	2.58	1.20
Carazinho	Brazil	22	2379	73.1	36.3	90	136	112	3.41	4.98	1.72	3.33	1.58	1.99
Magnif 42	Argentina	4	2272	74.6	33.7	87	131	101	4.00	5.03	3.49	2.73	2.60	1.00
Double Insignia	Australia	21	2261	69.1	31.2	89	134	86	2.86	4.76	3.49	3.63	5.25	1.00
Selkirk	Canada	11	2204	70.3	29.9	98	132	110	3.29	1.10	1.00	1.14	4.09	1.92
Buck Atlantico	Argentina	17	2188	71.7	28.2	90	133	108	3.78	2.06	1.20	4.57	3.05	1.00
Crim	U.S.A.	3	2135	71.5	29.6	88	133	105	4.16	5.38	2.20	1.08	2.05	1.36
Giza 144	Egypt	7	2087	72.6	34.2	84	128	101	4.13	4.66	3.28	1.88	2.94	1.20
Gabo	Australia	13	2031	65.4	31.5	81	122	87	2.81	6.85	1.99	4.80	3.20	1.00
Justin	U.S.A.	8	1897	70.2	25.8	99	137	108	3.53	1.74	1.72	1.69	2.87	2.67
Sonora 64	Mexico	20	1878	71.9	30.5	69	111	71	1.45	8.75	9.99	1.56	1.90	1.20
Thatcher	U.S.A.	5	1437	69.2	22.1	100	137	108	5.15	4.45	1.72	2.28	7.05	1.20
Mean			2382	71.6	32.2	84	126	98	3.49	4.11	2.22	2.32	3.16	1.60
Number of locations			12	10	8	10	6	11	6	4	2	5	9	2

[1] Data were not included for varieties 4, 13 and 25 at Fargo, North Dakota and for varieties 5, 8 and 11 at Cd. Obregon, Sonora. Data for yield but not other traits were included for varieties 13 and 20 at Quito, Ecuador. Lodging data from Minnesota was reported in units other than percentage and were not used in computing averages. Only the data from the normal planting date at Cd. Obregon were included in the means.

TABLE 27. Correlations between the means of 12 variables averaged over all locations where both variables were measured for the "4th Inter-American Spring Wheat Yield Nursery, 1963-64.

	Yield	Test wt.	1000 grain wt.	Days to flowering	Days to maturity	Height	Lodging	Stripe rust, $\sqrt{X+1}$	Stem rust, $\sqrt{X+1}$	Leaf rust $\sqrt{X+1}$	Shattering $\sqrt{\%+1}$
Test weight	.26										
1000 grain wt.	.54**	.28									
Days to flowering	-.46*	-.18	-.65**								
Days to maturity	-.20	.02	-.60**	.96**							
Height	-.20	.38	-.18	.65**	.62**						
Lodging $\sqrt{\%+1}$	-.36	.23	-.27	.19	.27	.76**					
Stripe rust, leaf $\sqrt{X+1}$	-.56**	-.27	-.27	-.33	-.18	-.56**	-.24				
Stem rust $\sqrt{X+1}$	-.13	-.05	-.02	.02	.12	-.17	-.09	-.18			
Leaf rust $\sqrt{X+1}$	-.28	-.44*	-.06	.06	-.10	-.09	.10	-.43*	.36		
Shattering $\sqrt{\%+1}$	.21	.30	1/	.20	.01	.20	.18	-.32	-.18	-.23	
Stripe rust, head $\sqrt{\%+1}$	-.18	-.08	-.05	-.19	1/	.48*	1/	.42*	.16	-.14	1/

* = Significant at the 5% level

** = Significant at the 1% level

1/ Not measured at the same locations

TABLE 28. Predicted yield (kg./ha.) and the number of "independent" variables involved in the multiple regression of these estimates for the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery," 1963-64.

Variety or cross	Variety number	ARGENTINA Paraná	ARGENTINA Pergamino	PARAGUAY Encarnación	CHILE Santiago	ECUADOR Quito	GUATEMALA Quezaltenango	MEXICO El Roque	MEXICO Ciudad Obregon early	MEXICO Ciudad Obregon normal	UNITED STATES 2/ California	UNITED STATES 2/ Minnesota	CANADA Manitoba	Mean
Gaboto	1	1627	2594	1975	4043	3765	2580	3848	1/	3174	3472	948	2114	2740
Tacuarí	2	1089	2389	2231	3753	3154	2639	3969	2257	3116	3397	1176	1917	2591
Crim	3	1487	2281	1787	3100	-32	2284	3397	2461	3256	3681	1510	1938	2263
Magnif 42	4	760	2415	2036	4336	2869	2585	3873	2622	2369	4110	737	631	2462
Thatcher	5	509	1156	958	3015	717	1936	3079	1/	1/	2705	1424	1517	1702
North Dakota # 81	6	1455	2486	2133	2965	1348	3198	3787	3505	4390	3681	1397	2069	2700
Giza 144	7	1114	2110	2030	3307	808	2512	3960	3670	4133	3860	1310	2065	2573
Justin	8	703	2020	1093	3251	2358	2729	3741	1/	1/	2889	1252	1895	2193
Lerma Rojo	9	829	2049	2255	4077	1349	2370	3573	3059	3371	3976	1467	1902	2523
Pitic 62	10	798	1424	2026	3030	2203	3862	4361	3954	4015	3606	1289	1675	2687
Selkirk	11	938	1513	1122	3206	2902	3990	3003	1/	1/	2896	1631	1454	2266
Nariño 59	12	1075	2068	2422	4201	2162	3857	4546	2360	2681	3719	1550	2081	2727
Gabo	13	1399	2049	2155	2335	1/	1792	3450	3674	4225	4257	1486	-101	2429
Nainari 60	14	1277	2466	2140	3337	1825	2855	3694	4456	4776	4386	1395	1844	2871
Bonza 55	15	775	2199	2137	3322	2797	3431	4024	3346	2686	3912	1243	1624	2825
Magnif 41	16	1351	2707	2159	3794	4180	1015	3479	4122	3412	3752	1645	1960	2798
Buck Atlantico	17	492	2249	1943	2709	1353	3071	3721	2292	3493	3720	986	1423	2288
Mayo 64	18	831	2082	2044	2572	1168	1880	3549	3925	4751	4136	1554	1275	2481
Lerma Rojo 64 A	19	903	1537	2062	4168	-101	2623	4125	3512	4219	4185	1562	2167	2580
Sonora 64	20	1332	1990	2076	2401	1/	1276	3525	2432	4285	4960	1519	1330	2466
Double Insignia	21	140	1369	1531	3551	2551	2273	4040	3648	4398	4483	1237	1666	2574
Carazinho	22	1225	2963	2401	3804	1098	3507	3450	3352	3308	3503	1015	2008	2636
Fr-KAD x Gb	23	685	2092	2197	3471	3333	2880	4070	2757	4208	4206	1602	1791	2774
Penjamo 62	24	1154	2524	1664	4058	2310	2959	3718	3345	4580	4482	1351	2029	2848
C-271	25	385	1535	1907	3538	3093	2823	4627	3831	4476	4587	1349	161	2693
Number of "independent" variables used		9	7	4	8	9	8	8	7	8	5	6	6	

1/ Data not reported or not used in multiple regression

2/ Multiple regression data for North Dakota not included as only one "independent" variable was reported

TABLE 29. The differences (kg./ha.) between observed and calculated yields (observed - calculated) for the 25 varieties in the "4th Inter-American Spring Wheat Yield Nursery", 1963-64.

Variety or cross	Variety number	ARGENTINA Paraná	ARGENTINA Pergamino	PARAGUAY Encarnacion	CHILE Santiago	ECUADOR Quito	GUATEMALA Quezaltenango	MEXICO El Roque	MEXICO Ciudad Obregon early	MEXICO Ciudad Obregon normal	UNITED STATES[2] California	UNITED STATES[2] Minnesota	CANADA Manitoba	Mean
Gaboto	1	110	108	439	-88	-26	331	64	1/	101	-206	-25	-79	66.3
Tacuarí	2	321	267	94	455	676	231	451	201	451	441	12	105	308.8
Crim	3	72	-102	-182	128	312	-36	233	464	-748	-350	42	209	3.5
Magnif 42	4	184	-281	141	-279	-882	78	339	-514	-177	-116	-94	-341	-186.8
Thatcher	5	-100	-240	-32	-773	-52	117	-872	1/	1/	119	213	-346	-196.6
North Dakota # 81	6	64	-300	317	174	-815	-783	238	-125	-448	367	158	210	-78.6
Giza 144	7	-122	-463	131	-941	-353	19	-404	-220	-1150	338	-89	-182	-286.3
Justin	8	-96	-541	-268	-231	-223	-188	-614	1/	1/	-255	368	-205	-225.1
Lerma Rojo	9	-136	-298	61	-79	-6	-305	426	246	1179	252	97	-197	103.3
Pitic 62	10	-58	708	394	970	1083	595	539	113	1468	318	128	188	535.5
Selkirk	11	-150	249	-249	646	70	-187	27	1/	1/	-294	-175	315	25.2
Nariño 59	12	69	5	-314	596	-25	-271	-55	289	-214	297	-83	116	34.2
Gabo	13	92	139	51	-511	1/	-570	-228	564	-16	-359	219	359	-23.6
Nainari 60	14	-16	277	215	317	-590	741	684	88	-217	-328	196	362	144.1
Bonza 55	15	1	-190	-402	-25	264	106	480	-393	39	742	-198	148	47.7
Magnif 41	16	163	101	18	-616	-286	124	64	133	-3	-177	-228	-174	-73.4
Buck Atlantico	17	-39	737	662	64	-286	60	222	52	-484	-94	37	-366	48.8
Mayo 64	18	187	636	-575	528	-443	437	334	452	241	249	97	-8	177.9
Lerma Rojo 64 A	19	-48	-139	132	245	566	-124	128	70	1098	-520	-88	95	117.9
Sonora 64	20	-347	-485	-369	-162	1/	-228	-235	-72	-985	-288	-182	-84	-310.6
Double Insignia	21	163	131	24	496	186	-246	-676	-390	-523	-2	-50	-190	-89.8
Carazinho	22	-282	49	-334	-104	393	-554	255	-142	33	-588	-131	377	-85.7
Fr-KAD x Gb	23	22	10	-349	-135	245	209	-756	-574	-775	-129	-15	-88	-194.6
Penjamo 62	24	-27	-92	583	-327	-160	387	98	66	862	597	119	-188	159.8
C-271	25	-27	-287	-189	-347	351	55	-441	-309	268	-14	-348	-38	-110.5
Number of "independent" variables used		9	7	4	8	9	8	8	7	8	5	6	6	

1/ Data not reported or not used in multiple regression

2/ Multiple regression data for North Dakota not included as only one "independent" variable was reported

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